The Vesta/non-vestoids connection: Is there another differentiated object out there?

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(4) Vesta, an asteroid of 530-km diameter, is the biggest ”small body” to show a basaltic crust. Because of the spectroscopic similarity, Vesta was considered to be the parent body for Diogenite, Howardite, and Eucrite meteorites [1], collectively known as the HED meteorites. The discovery of small chunks of basaltic material in the proximity of our planet [2] led to the classical scenario: multiple giant impacts in the south pole of Vesta, observed by HST and Dawn [3,4], generated a swarm of basaltic objects, the so-called ”vestoids”. Some were ejected on close orbital elements and created Vesta's dynamical family [5]. Others, extracted from a close encounter with a terrestrial planet, became near-Earth objects (NEOs) [6], or Mars-crossers [7]. This scenario is strengthened by a number of facts: the HED meteorites share a similar oxygen isotopic ratio [8] and members of the dynamical family show a basaltic, V-type composition, according to the current taxonomy [9], similar to that of (4) Vesta.

V-type asteroids were also found outside the boundaries of the dynamical family: while at least one group could be considered as ”fugitives” from the Vesta family [10]), it is difficult to explain the low-inclination middle-belt vestoids, as well as the outer-main-belt V-types, beyond 2.7 au. (1459) Magnya, the first basaltic asteroid discovered beyond Vesta's limits [11], raised the possibility that a second, differentiated asteroid exists in the main belt. The discovery of (21238) Panarea, a second basaltic asteroid not conventionally linked to Vesta, called the classical model into question [12].

These ”V-type non-vestoids” in the middle and outer belt are generally very faint [12,13], and the noise in the spectrum can lead to an erroneous taxonomic classification, particularly if based only on the visible spectrum: in the current taxonomy [9], there are at least four classes with a deep 1-µm absorption band. Up to now, only three of them were confirmed as basaltic asteroids, with the discovery of the prominent 2-µm band: (1459) Magnya, (10537) 1991 RY_{16}, and (21238) Panarea. It is noteworthy to underline that they all lie on the other side of the 3:1 resonance, and, according to our current understanding of dynamical models, it would be very unlikely that a fragment survived through the passage of such a powerful resonance.

We therefore analyzed V-type asteroids belonging to different dynamical families — i) vestoids, ii) fugitives, iii) low-inclination vestoids, iv) NEOs, and v) non vestoids — to highlight possible differences among dynamical types and to compare each class with the HED meteorites. In the visible range, we made use of several spectral parameters, such as the reflectivity gradients in the 0.5–0.7-µm and 0.8–0.92-µm ranges, the relative maximum, and the apparent depth [14]. In the NIR range, we made use of parameters normally compared in the literature (band centres, band depths, band separation) to infer mineralogical properties [15], as well as different pyroxene compositions [16]. Finally, we compared band parameters from V-types with data available from the Visible and InfraRed spectrometer (VIR) onboard the Dawn mission [17], which mapped almost the whole surface of Vesta and acquired a total amount of 20 million spectra in 864 spectral channels. All of the data are currently under analysis and the results will be presented at the ACM meeting.

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